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COMPARISON OF PERFORMANCE OF VCRS WITH DIFFERENT MODES OF CONDENSER COOLING WITH DIFFERENT REFRIGERANT

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ABSTRACT

This paper compares the performance of refrigeration systems employing two typesofcondensers, namely the air-cooled, the water-cooled condenser The experiment was done using HFC134a and HC(LPG) as the refrigerant.The performance of the refrigeration systems with air-cooled and water-cooled condenser was compared with refrigerant HCF134a and LPG.. The results indicate that the refrigeration systems performance had improved when water-cooled condenser was used with refrigerant HCF134a. Water-cooled condenser reduced the energy consumption when compared with the air-cooled condenser. There was also an enhancement in coefficient of performance (COP) when water-cooled condenser was used with refrigerant HCF134a instead of air-cooled condenser with refrigerant HCF134a or LPG. The water-cooled heat exchanger was designed and the system was modified by retrofitting it, instead of the conventional air-cooled condenser by making a bypass line and thus the system can be utilized as a waste heat recovery unit. The hot water obtained can be utilized for household applications like cleaning, dish washing, laundry, bathing etc. Experimental result shows that about 200 liters of hot water at a temperature of about 52ºC over a day can be generated and thus the system signifies the economic importance from the energy saving point of view.

Keywords: condenser, refrigerant,R134a, LPG.

I. INTRODUCTION

A refrigerator is a common household appliance that consists of a thermally insulated compartment and which when works, transfers heat from the inside of the refrigerator to its external environment so that the inside of the thermally insulated compartment is cooled to a temperature below the surrounding temperature of the room. . Heat rejection may occur directly to the air in the case of a conventional household refrigerator having air-cooled condenser or to water in the case of a water-cooled condenser. Tetrafluoroethane (HFC134a) and LPG(HC) refrigerant was now widely used in most of the domestic refrigerators and automobile air- conditioners and are using POE oil as the conventional lubricant. Heat can be recovered by using the water-cooled condenser and the system can work as a waste heat recovery unit. The recovered heat from the condenser can be used for bathing, cleaning, laundry, etc. The modified system can be used both as a refrigerator and also as a water heater. Therefore by retrofitting a water-cooled condenser it produce hot water and even reduce the utility bill of a small family. In this system the water-cooled condenser is designed as a tube in tube heat exchanger of overall length of 6m. It consists of an inlet

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for the cooling water and an exit for collecting the hot water. The hot water can be used instantly or it can be stored in a thermal storage tank for later use.

1.1 Vapor Compression Cycle

The vapor compression cycle is the most widely used method of refrigeration in the modern application. Your household refrigerator, water cooler, deep freezer, air-conditioner etc., all run on vapor compression cycle. The cycle is called as vapor compression cycle, because thevapors of refrigerant are compressed in the compressor of the system to develop the cooling effect.

1.1.1 Working

1.1.1.1. Compression

The vapors of refrigerants enter the compressor and get compressed to high pressure and high temperature. During this process the entropy of the refrigerant ideally remains constant and it leaves in superheated state.

1.1.1.2. Condensation

The superheated refrigerant then enters the condenser where it is cooled eitherby air or water due to which its temperature reduces, but pressure remains constant and gaseous state gets converted into liquid state.

1.1.1.3. Expansion

The liquid refrigerant then enters the expansion valve or capillary tube when sudden expansion of the refrigerant occurs, due to which its temperature and pressure falls down. The refrigerant leaves expansion valve or capillary tube in partially liquid state and partially in gaseous state.

1.1.1.4. Evaporation or Cooling

The partially liquid and partially gaseous refrigerant at very low temperature enters the evaporator where the substance to be cooled is kept. It is here where the refrigeration effect is produced. The refrigerant absorbs the heat from the substance to be cooled and gets converted into vapor state. Here are the various process of Vapor compression cycle (refer the figure)

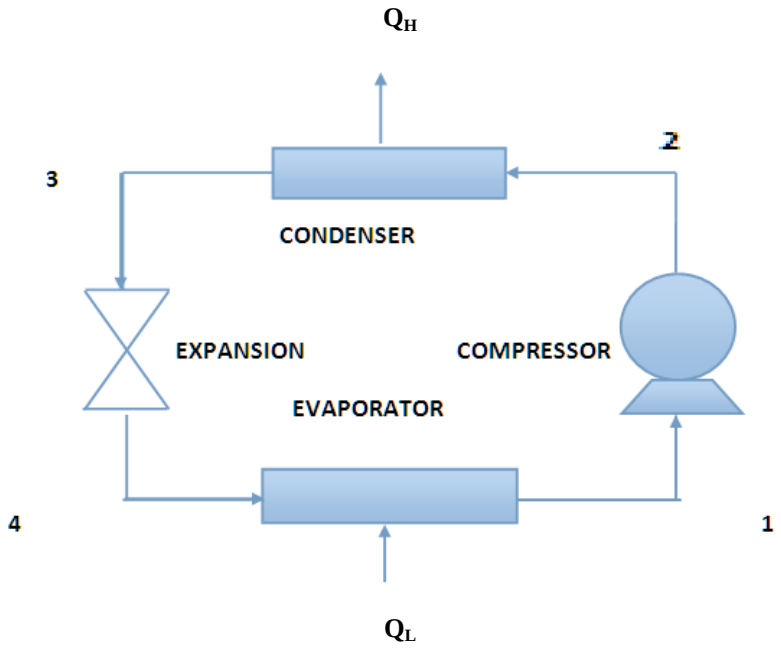

Fig.1.1: Schematic diagram of refrigeration system

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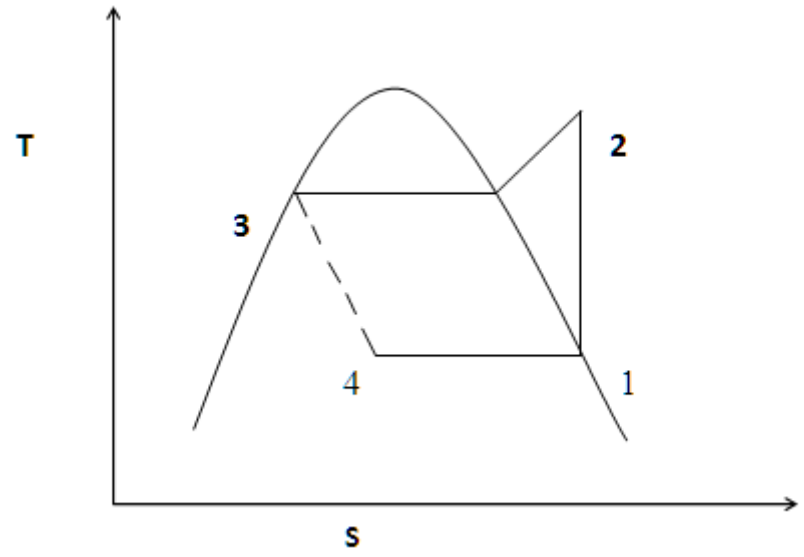

Fig1.1.2: T-S diagram of VCR system

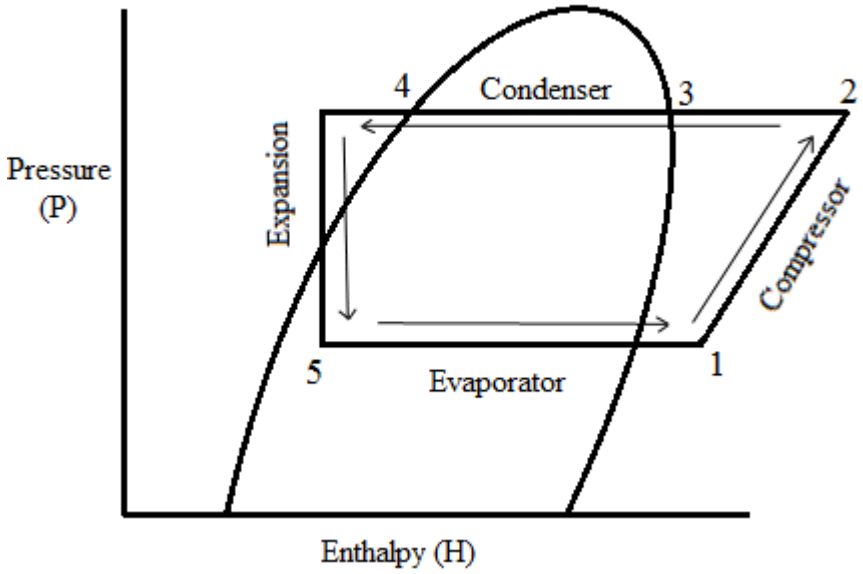

Fig1.3: P-H diagram of VCR system

1.2 Refrigerant

1.2.1 Properties of R134a

non-toxic, non-flammable and

non-corrosive.

It exists in gas form when expose to the environment as the boiling temperature is -14.9°F or -26.1°C.

1.2.2 Properties of LPG

Colorless.

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Odorless (It's normal to odorize LPG by adding an odorant prior to supply to the user, to the aid detection of any leaks). □

Heavier than air.

Liquid LPG is half the weight of water.

Non-toxic.

LPG expands upon release and 1 liter of liquid will form approximately 250 liters of Vapor.

II. EXPERIMENTAL SETUP

2.1. Experimental System

The system was modify with a water-cooled condenser instead of the conventional air-cooled condenser by making a bypass line. Water-cooled condenser is a tube in tube heat exchanger having an inlet for the cooling water and an exit for collecting the hot water. The modified refrigerator was properly instrumented with temperature indicators and pressure gauges . The temperature at various points was noted using digital thermocouples.Pressure gauges used in this experiment are of bourdon tube type gauges. Dead weight pressure gauge tester using the principle of Pascal's law was used as the calibration equipment. Evaporator and condenser pressure are noted using calibrated pressure gauges. shows the experimental test rig. The retrofitted water-cooled condenser can also been seen. The refrigerator specifications are given below.

2.1.1. Technical details

[1] Cooling Capacity: 450 Watts at rated test

[2] conditions* (1/6TR)

[3] 1/4 HP Hermetically sealed

[4] air cooled condenser and water cooled condenser

[5] Refrigeration System Condenser fan with

[6] axial flow type

[7] Molecular sieve type drier/ filter

[8] . Expansion device: Direct expansion type

[9] Shell & Coil type provided

[10] Evaporator: Copper/M.S. shell suction line

[11] accumulator provided

[12] Accumulator is R-134 a and LPG

2.2 Experimental Procedure

Schematic diagram of the experimental apparatus is shown in Figure 2. After the integration of the components, the valve V 3 and V 4 was closed to make the system work only with the air- cooled condenser and V 1 and V 2 was closed to make the system work only with the water-cooled condenser. Refrigerants are charged one by one into the refrigerator. The refrigerator is initially provided with HCF134a. Then after removing this refrigerant,LPG(HC) is

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charged into the system and taking the observations the refrigerant.by keeping the evaporator temperature -15 The time is noted for all refrigerants when the compressor cuts off. The compressor has power rating of 1/6 hp.

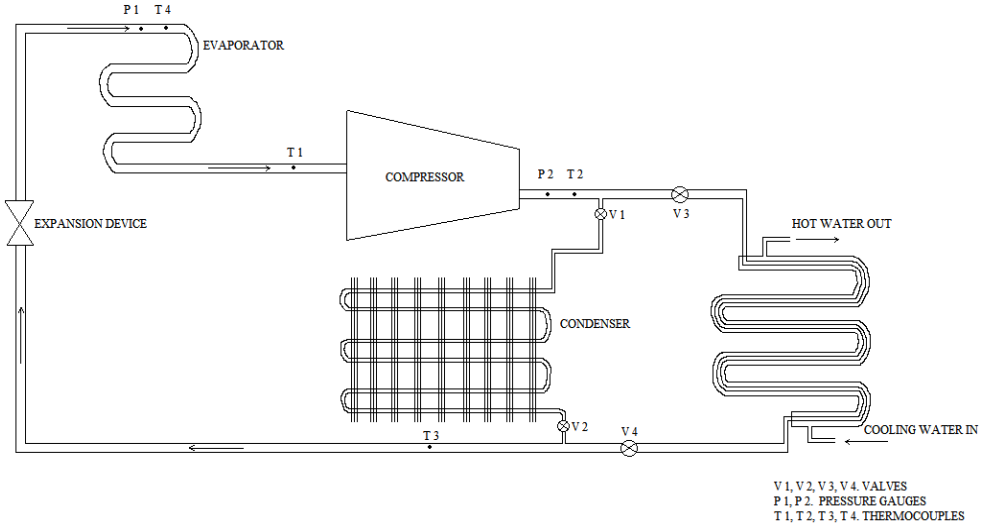

Figure 2.1 Schematic diagram of the experimental apparatus

III. RESULTS AND DISCUSSIONS

1HP = 745.7W

1/6HP =745.7×1/6 = 124.28W

(1/6 HP compressor used in this experiment

Refrigerant charged one by one into the refrigerator .and takes the reading .and observed how much time takes by each ref. In diff modes of condenser cooling to attend evaporator temperature -15ºC.

Total Power consumption = 124.28 × Total running time.

For R - 134a,

In air cooled,

Total power consumption = 124.28× 0.2166 = 26.92wh

In water cooled

Total power consumption = 124.28× 0.18 = 22.78wh

For HC (LPG),

In air cooled

Total power consumption = 124.28×0.716 = 89.06wh

In water cooled

Total power consumption = 124.28×0.6166 = 76.63wh

So, more Power consume in HC (LPG) with air cooled condenser.

1. Now comparison of Power saving using HC (LPG) in air cooled condenser with refrigerant LPG in water cooled condenser.

= (89.06-76.63)

=12.43wh

% Power saving = 13.95%

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1) Power saving using R - 135a in place of HC (LPG) in air cooled condenser.

= (89.06 - 26.92)

= 64.14

% Power saving = 69.77%

2) Now comparison of Power saving using HC (LPG) in air cooled condenser with refrigerant HCF134a in water cooled condenser.

=(89.06 - 22.78)

=66.28

% power saving = 74.42 %

IV. CONCLUSION

R-134a provides better refrigeration effect in comparison to LPG

By using R-134a the compressor work is reduced by 64.14% in air cooled condenser.

Water cooled condenser consume less power than air cooled condenser.

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